NON-PUBLIC?: N
ACCESSION #: 8905230175
LICENSEE EVENT REPORT (LER)

FACILITY NAME: DIABLO CANYON, UNIT 2 PAGE: 1 OF 11

DOCKET NUMBER: 05000323

TITLE: LOW LOW STEAM GENERATOR WATER LEVEL REACTOR TRIP DUE TO A
TEMPORARY VOLTAGE TRANSIENT
EVENT DATE: 04/16/89 LER #: 89-005-00 REPORT DATE: 05/16/89

OPERATING MODE: 1 POWER LEVEL: 052

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: DAVID P. SISK, REGULATORY COMPLIANCE
ENGINEER TELEPHONE: (805)595-4724

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE TO NPRDS:

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On April 16, 1989, at 2004 PDT, a reactor trip due to low low steam generator (SG) water level occurred following a main generator trip and transfer of all electrical buses. At 2056 PDT, a 4-hour non-emergency report was made to the NRC in accordance with 10 CFR 50.72.

An Event Investigation Team (EIT) was established to investigate the event. Based on inspections, tests performed and a review of available information, the EIT determined that actuation of the generator backup protective relay caused the main generator trip. Coincident with the generator breakers opening, all vital buses transferred to standby power. A circulating water pump failed to restart on this transfer preventing the actuation of the condenser steam dumps. SG pressure increased causing SG level to shrink to the low low SG water level reactor trip setpoint.

Additional instrumentation was installed for the unit restart. No

abnormalities were observed during the restart of the unit. The generator backup relay actuation was caused by a temporary voltage transient. The circulating water pump failure to restart was caused by a failure to adequately control equipment removed from service. Applicable procedures are being revised and Operations issued an incident summary to all applicable personnel.

END OF ABSTRACT

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I. Plant Conditions

The unit was in Mode 1 (Power Operation at 52 percent power).

II. Description of Event

A. Event:

On April 16, 1989, at 2004 PDT, a reactor trip due to low low steam generator (SG) water level occurred following a main generator trip and transfer of all electrical buses. The chronology of the event is as follows:

1. Pre-event conditions

a. On April 7, 1989, at 0434 PDT, circulating water pump (CWP) 2-1 (KE)(P) breaker 52-VD-5 (EA)(BKR) was racked out per clearance request and the associated switching log. Potential transformer drawer (EA)(XPT) was racked out in accordance with the switching log but no tag was hung since there was no requirement on the clearance request. The potential transformer drawer should have been tagged and added to the clearance.

On April 10, 1989, at 1800 PDT, the clearance requests were removed from CWP 2-1 breaker 52-VD-5. Since no tag was listed for the potential transformer drawer, it was assumed to be unaffected by the clearance and this step was marked "not applicable" on the switching log to restore the breaker/pump. Circulating water pump 2-1 breaker 52-VD-5. was racked in with the potential transformer left racked out.

b. On April 16, 1989, at 2004 PDT, generator backup trip relay (21G2) (EL)(RLY) and the generator undervoltage relay (27G2) activated causing power circuit breakers 542/642 (EL)(BKR) to open. With both power circuit breakers open and the generator undervoltage relay, actuated, the 12kV and 4kV buses auto transferred to start-up power.

c. Due to the potential transformer drawer being racked out, the auto-reclose on bus transfer feature on CWP 2-1 was effectively locked dout (anti-pumping) due to simultaneous trip and close signals through interlocking contacts. This prevented the automatic restart of the CWP. Control interlock C-7A (>10 percent load rejection) satisfied one of the conditions necessary to actuate the 40 percent condenser dump valves, but the main condenser (KE)(COND) was no longer available due to circulating water being unavailable (control interlock C-9) therefore, the 40 percent condenser steam dumps were not available.

d. Pressurizer power operated relief valve PCV-455C (AB)(RV) actuated in response to increased reactor coolant system pressure due to the turbine load rejection and the absence of the condenser steam dump heat sink. Without circulating water, the main condenser was unavailable and the 40 percent condenser dumps were blocked. Since control interlock C-78 (>50 percent load rejection) did not actuate, the 35 percent dumps and 10 percent dumps remained blocked during the load rejection.

2. Event

a. On April 16, 1989, at 2004 PDT, the Unit 2 reactor tripped due to SG 2-3 low low water level. When the turbine valves shut on the load reduction and steam dumps failed to open, SG pressure increased causing level to shrink to the low low SG level reactor trip setpoint.

The main feedwater pumps tripped during the event, causing a loss of capability to make up to the SGs with the main feedwater system. This would have resulted in a subsequent reactor trip on SG low low water level even if the circulating water pump problem had not occurred.

b. At 2009 PDT, a unit trip was manually initiated in
accordance with applicable emergency procedures.

c. At 2012 PDT, the main steam isolation valves (MSIVs) were manually shut from the control room since circulating water for the condenser was not available. The condenser was vented to prevent overpressurization.

d. At 2036 PDT, CWP 2-2 was started.

e. On April 16, 1989, at 2050 PDT, the plant was stabilized at normal operating pressure and temperature.

B. Inoperable structures, components, or systems that contributed to the event:

Due to the potential transformer drawer being racked out, the auto-reclose on bus transfer feature on CWP 2-1 was effectively locked out (anti-pumping) due to simultaneous trip and close signals through interlocking contacts.

C. Dates and approximate times for major occurrences:

1. On April 7, 1989, at 0434 PDT: CWP 2-1 breaker and potential transformer are racked out.

2. On April 10, 1989, at 1800 PDT: CWP 2-1 breaker is racked in with the potential transformer left racked out.

3. On April 16, 1989, at 2004 PDT: Generator backup relay (21G2) and generator undervoltage relay (27G2) actuate.

4. On April 16, 1989, at 2004 PDT: Reactor trip due to SG 2-3 low low water level, (turbine trip and main feedwater pump trip also occurred)

5. On April 16, 1989, at 2009 PDT: Unit trip manually initiated.

6. On April 16, 1989, at 2012 PDT: MSIVs manually shut from

the control room due to the
condenser not being available
(no CWP immediately
available). Condenser vented
to prevent
overpressurization.

7. On April 16, 1989, at 2036 PDT: CWP 2-2 started.

8. On April 16, 1989, at 2050 PDT: Plant stabilized at normal operating pressure and temperature.

D. Other systems or secondary functions affected:

None

E. Method of discovery:

The event was immediately known to the control room operators because of numerous alarms and other indications.

F. Operator actions:

The unit was stabilized in Mode 3 (Hot Shutdown) in accordance with approved plant emergency procedures.

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G. Safety system responses:

1. The reactor tripped.

2. The main turbine tripped.

III. Cause of the Event

A. Immediate Cause:

The reactor tripped due to low low water level in steam generator 2-3. This low low water level was the result of shrink due to the steam pressure increase that resulted when the turbine valves closed and the steam dumps failed to open to compensate.

B. Root Cause Analysis:

PG&E conducted an extensive investigation of the potential causes of this event using a multidisciplinary Event Investigation Team that included system protection and corporate engineering personnel. Potential causes for the initiating event were analyzed as follows:

1. Line fault on a 500 kV line, main transformer, generator or isophase bus.

This was determined not to be the cause since 1) there was no physical evidence of damage to equipment that would have been present if generator backup trip relay (21G2) had actuated on a fault, 2) and the generator undervoltage relay (27G2) was the only other plant or 500 kV switchyard primary protective relays that actuated.

2. Relay failure

The failure of any of the relays associated with the event, the generator backup trip relay (21G2), the timing relay for the backup trip relay (62G2), or the generator undervoltage relay (27G2) was determined to not be the cause since all the relays were individually checked for calibration and operation (see investigation below) and were found to be acceptable. Automatic transfer logic was not simulated by faulty motor operated disconnect auxiliary contacts. Testing verified this conclusion.

Testing assured that no unknown circuits existed which would directly transfer busses after 500 kV breaker tripping. Bus transfer could have only occurred through generator undervoltage (27G2), combined with the opening of the 500 kV breakers. Only a loss of either isophase bus "B" or "C" phase potential could actuate the generator undervoltage relay (27G2).

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3. Personnel Activities

Direct or indirect personnel intervention in the cable spreading room or the isophase bus/MOD room was determined not to be the cause since the security entry log showed no one entering, leaving, or in these areas immediately before, during, or immediately after the event.

4. Work activities

Ongoing work was determined not to be the cause since there was none in the area of the relays involved in this event or on any system that could have potentially caused this event (see investigation below).

5. 500 kV fault on system side of 500 kV switchyard

A 500 kV line fau
t that occurred on the system side of the 500
kV switchyard was determined to not be the cause since the 500 kV switchyard relays are more sensitive than the generator backup trip relay (21G2) and did not pick up any disturbances (see investigation below).

6. Loss of isophase voltage Only loss of isophase voltage could trip the generator backup trip relay (21G2) in this instance because:

a. A fault beyond the 500 kV breakers would be cleared by these breakers and no unit (86G2/86G21) trip relay actuation or bus transfer would have occurred.

b. A fault between the 500 kV breakers and the generator would cause a unit trip relay actuation since opening of the generator output breakers would not have cleared the fault.

c. Loss of current sensing will not trip the generator backup trip relay (21G2) and cannot trip the generator undervoltage relay (27G2).

d. Only the "B" phase flag was dropped on the generator backup trip relay (21G2).

e. The generator undervoltage relay (27G2) senses voltage between "B" and "C" phases only.

f. Bench testing of the generator backup trip relay (21G2) relay determined that a loss of "B" phase potential at 50 percent generator load current will actuate the relay. Current below 50 percent generator load will not actuate the relay.

C. Investigation:

The alarm printout indicated generator backup trip relay (21G2) to be the initiating source of the event. Visual inspection of the relay indicated only a "B" phase relay flag actuation. Further visual inspection revealed the generator undervoltage relay (27G2). had also actuated initiating the automatic bus transfers. The actuation of the generator backup trip relay should have indicated a line fault. However, since the 500 kV breaker directional overcurrent, unit overall differential, and generator differential relays did not indicate a line fault, either relay failure or spurious actuation was suspected. This event was traced to a probable transient voltage condition on "B" phase. To verify this assumption, the following tests were performed:

1. All potential transformer dr.aictser4 were verified to be properly locked in place prior to opening them for inspection.

2. Continuity of internal connections was verified by several methods:

a. An ohmmeter was used to verify continuity between all junction areas. The test was performed with the potential transformers in their racked-in position and continuity was verified from the high voltage side spring connection through the transformer to the low side cubical ground connection.

The continuity of the secondary side wiring was also verified from the secondary disconnect through secondary fuses to the individual relay terminals. Several instances of slight termination connection closeness were recorded. but these conditions were not considered problem sources. The primary and secondary fuses were checked for continuity.

b. Amperage capacity of the secondary circuit was assured by introducing approximately five amperes of current at low voltage through all secondary conductors.

c. Insulation condition of the secondary circuit was assured by connecting a temporary 120 Vac power source to the entire secondary circuit. The 120 Vac was measured at all connected relays.

d. The insulation on the potential transformers was tested satisfactorily (meggered) winding to winding and windings to ground.

e. The potential transformers vere turns ratio tested.

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f. A visual inspection of each phase drop from the isophase bus, including the current limiting resistor, was performed. No deficiencies were noted.

g. The ground lead on the secondary side of the potential transformer was temporarily removed and the circuit insulation tested (Meggered). The existence of a single ground reference was confirmed.

3. To assure that no generator damage existed, voltage and impedance were measured between each isophase bus drop and the generator neutral lead at the grounding transformer.

4. The generator backup trip relay (21G2), timing relay for the backup trip relay (62G2), and the generator undervoltage relay (27G2) were removed, inspected for mechanical failures, and checked for proper calibration and response.

a. The as-found calibration parameters were acceptable for the generator backup trip relay (21G2). No mechanical degradation was observed.

The phase shift transformer, (YT), associated with the generator backup trip relay was checked for continuity and windings were meggered. All tests were satisfactory. A termination bushing in the case penetration was slightly loose. However, no malfunction would result from this looseness.

b. The timing relay for the backup trip relay (62G2) appeared normal when removed for inspection. However, when energized for initial testing the relay failed to reset. Inspection of the relay identified the mechanical stop had slipped, causing the relay rotor to overtravel and bind between the relay pole pieces which did not allow the relay to reset. The stop was readjusted and the relay tested satisfactory. This did not contribute to this event since the binding would only occur after full timer travel (> 2 seconds) and the timer was found in the reset position.

c. The generator undervoltage relay (27G2) was inspected and tested for proper operation. All as-found calibration parameters were acceptable. However, a slight mechanical interference between the relay disc and the permanent magnet was observed. This interference did not affect relay operation.

5. Functional Testing of the generator backup trip relay, the timing relay for the backup trip relay, and the generator undervoltage relay was conducted with no unexpected responses recorded.

6. A unit overall differential relay, 87U2, cyclic alarm was received following the trip, but was considered spurious. All differential inputs to the relay had been de-energized for approximately 13 minutes after the manual unit trip through relays 86G2/86G21. Under this condition, an actual differential condition is not possible. In addition, there was no relay flag drop indicated.

The alarm inputs apparently resulted from vibration of the auxiliary relay, 87XU2, during turbine coastdown. Actual actuation of this auxiliary relay was discounted since the relay seals-in on actuation and bumping of the relay cabinet does not initiate an alarm. The relay was tested and found to function properly. No further problems have been identified following unit restart.

7. The CWP 2-1 failed to restart after the auto transfer due to lockout condition of CWP feeder breaker, the CWP undervoltage relay (52-VD-5). The lockout was caused by simultaneous trip and close signals to the breaker through an interlock contact from 27-VD-5. This contact delays the restart signal until motor feeder voltage decays and the auto transfer trip signal is removed. This incorrect logic resulted from inadvertent removal

of the potential signal due to the potential transformer drawer being racked out. The potential transformer drawer was left racked out because the potential transformer drawer was not tagged out when it was racked out along with the CWP 2-1 pump motor breaker. Since the potential transformer drawer was not tagged, when the pump clearances were removed, the personnel returning the CWP to service did not know to return the potential transformer drawer to service. This was determined to have been caused by personnel error, cognitive, in that a licensed operator exceeded the scope of the clearance and the referenced procedure. This resulted in inadequate plant equipment status control.

8. The only single device that can transfer all seven busses together are the unit trip relays which were not actuated. The only other probable method is to have an actuation of the generator undervoltage relay along with the opening of the power circuit breakers as occurred in this event. It is improbable that any other scenario could have caused the transfer of the busses (i.e., all seven motor operated disconnect auxiliary contacts simultaneously failing closed).

9. Back feeding to the plant on May 18, 1989 verified that no fault existed between the 500 kV yard and the main bank, up to the isophase bus motor operated disconnect.

10. All main generator protective devices of concern were calibrated and functionally tested during the fall 1988 refueling outage. Any actuation of these relays would have actuated the unit trip relays.
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D. Conclusion:

None of the inspections or testing performed revealed conditions which would have caused the event. Therefore the root cause of the event is undetermined. The EIT determined the protection relay actuations were caused by a transient voltage condition on the isophase bus metering and relaying "B" phase potential transformer. The generator backup trip relay (21G2) actuated long enough to trip the 500 kV breakers (approximately 1.5 second setpoint on the generator backup timing relay (62G2)), but not long enough to trip the unit trip lockout relay (86G21) (approximately 2 second setpoint on the generator backup timing relay (62G2)). Coincident with the

generator trip breakers opening, all vital buses transferred to
standby power because relay 27G2 sensed an undervoltage condition.

The potential transformer drawer was not tagged out when it was racked out along with the CWP 2-1 pump motor breaker. When the pump clearances were removed. the personnel returning the CWP to service did not know to return the potential transformer drawer to service since the potential transformer drawer was not tagged out. This was determined to have been caused by personnel error, cognitive in that a licensed operator exceeded the scope of the clearance and the referenced procedure. This resulted in inadequate plant equipment status control. The circulating waterpump failed to restart after the bus transfer, causing the loss of the condenser steam dumps during the load rejection. With no heat removal capability, the SG pressure increased causing SG level to shrink to the low low SG water level reactor trip setpoint.

IV. Analysis

A turbine trip/reactor trip is a previously analyzed condition 2 event described in the plant Final Safety Analysis Report Update. The reactor was stabilized in Node 3 in accordance with previously approved emergency operating procedures. All safety equipment operated per design. Thus the health and safety of the public were not adversely affected by this event.

V. Corrective Actions

A. Immediate Corrective Actions:

1. An Event Investigation Team was established by the Plant Manager, in accordance with an approved plant procedure to investigate the event, determine the cause, and applicable immediate and long term corrective actions. The unit was maintained in Mode 3 until those actions designated by the EIT as required prior to restart were complete.

2. Additional instrumentation was installed for the unit startup to monitor for any potential abnormalities. No abnormalities were observed during the startup.

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B. Corrective Actions to Prevent Recurrence:

1. Generator backup relay actuation

Due to the absence of an identified cause for the voltage transient, no additional corrective actions have been determined that would prevent recurrence of this event.

2. Reactor Trip

a. Breaker specific switching logs will be developed and incorporated into a revision of all applicable operating procedures (affecting 4 kV and 12 kV equipment).

b. Administrative procedure C-153, "Plant Status Controls," was revised to require documentation of all equipment status changes.

C. A special test procedure will be prepared to determine the cause of the main feedwater pump trips that occurred during this event. This test will be performed during the next Unit 2 refueling outage.

d. An Operations Department Incident Summary was issued to describe the event to all applicable personnel.

VI. Additional Information

A. Failed Components:

Not applicable

B. Previous similar events:

None

C. Additional Information:

Although no previous similar events have occurred at Diablo Canyon, a similar event was recently reported at Nine Nile Point Unit 2. This event started as a generator load rejection from an undetermined cause. The Nine Nile Point Unit 2 event was more significant due to the failure of one of the vital buses to transfer to offsite reserve power. The event is still being investigated.

ATTACHMENT 1 TO 8905230175 PAGE 1 OF 1

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415/972-7000
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James D. Shiffer
Vice President
Nuclear Power Generation

May 16, 1989

PG&E Letter No. DCL-89-138

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555

Re: Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
Licensee Event Report 2-89-005-00
Low Low Steam Generator Water Level Reactor Trip Due to a
Temporary Voltage Transient

Gentlemen:

Pursuant to 10 CFR 50.73(a)(2)(iv), PG&E is submitting the enclosed Licensee Event Report (LER) regarding a low low steam generator water level reactor trip due to a temporary voltage transient. The cause of the transient is undetermined.

This event has in no way affected the public's health and safety.

Kindly acknowledge receipt of this material on the enclosed copy of this letter and return it in the enclosed addressed envelope.

Sincerely,

J.D. Shiffer

cc: J. B. Martin
M. M. Mendonca
P. P. Narbut
B. H. Vogler
CPUC
Diablo Distribution
INPO

Enclosure

DC2-89-OP-NO46

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